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Instar Development of the Douglas-Fir Tussock Moth in Relation to Field Temperatures

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Abstract

Instar development is recorded for the Douglas-fir tussock moth (*Orgyia pseudotsugata*) for two different elevations in the Boise National Forest, Idaho, in 1991. The percentage of the population by instars is associated with accumulated degree-days after eclosion, which can be used to predict the proper timing for spray application. For all practical purposes, areas can be released for spraying when third instars are intially found.

Keywords: Douglas-fir tussock moth, insects, larval development, aerial application.

Introduction

The Douglas-fir tussock moth (DFTM; *Orgyia pseudotsugata* (McDunnough)) periodically reaches high-density populations that cause severe defoliation of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and true firs (*Abies* sp.), often leading to reduced growth, top-kill, and tree mortality (Wickman 1978). To effectively reduce losses, forest pest management personnel must be able to time direct control tactics to coincide with susceptible stages of larval development.

Like most lepidopterous defoliators, the DFTM has several instars present at the same time. Knowledge of the proportion of the population in each larval instar at any given time can be used to determine when to release specific areas for spray application. It is sometimes difficult for temporary summer employees to properly identify certain instars, even though the general characteristics have been published (Beckwith 1978). If any one instar can be identified with certainty, proper decisions can be made when the spread of instars is known for any specific time. As an example, areas usually are released for spray application when about 75 percent or more of the population is in the second instar. Field personnel, however, feel that they can identify third instars easier than second instars. Therefore, a knowledge of the percentage of third instars present when 75 percent of the population are second instars or higher would be helpful to make proper decisions.

Wickman (1976a) shows that about 400 degree-days Fahrenheit (222 degree-days Celcius) are required for overwintering DFTM eggs to hatch. Once hatching has occurred and the young larvae disperse to the new foliage, their development is closely associated with tree phenology (Wickman 1976a, 1976b), host foliage (Beckwith 1976), and the prevailing environmental conditions. Although the relation between laboratory temperatures and rates of larval development is known, this relation may differ

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under fluctuating temperatures and other physical factors experienced in the field (Beckwith 1982). Wickman (1976a, 1976b) recorded peak instar development associated with degree-days; however, he does not report the spread of the various instars over time.

A resurgence of DFTM in the Boise National Forest occurred in 1990-91. In connection with a research spray test, instar development was followed in two different areas to determine the distribution of instars over time. The feasibility of identifying the proportion of the population in the third instar as a trigger for treatment was evaluated.

Methods

Larvae were collected periodically after eclosion by beating the lower crowns of 10 Douglas-fir trees under a modified technique developed by Mason (1979). Only 10 trees were used because enough larvae were collected with this number for the purpose of instar distribution over time. The larvae from each tree were placed in a separate vial containing 80 percent ethyl alcohol and returned to the laboratory. Each larva was identified to instar at the end of the field season. Temperatures were recorded by Datapod[R] at an elevation similar to our lower plot.[1] The recording site was established on April 18 in the general research area and as high in elevation as possible because of snow conditions; this was before any research plots were located and established. An additional Datapod[R] was established on June 19 adjacent to one of the higher plots (2073 meters) to record temperatures during larval development.

The collection was terminated after August 22 because most larvae were in the sixth instar and some males at the lower elevation plot had started to pupate.

Results and Discussion

Spring and early summer of 1991 were unseasonably cold, which resulted in a delay in hatching of the DFTM. General hatching of the egg masses occurred on June 25 and July 2 for the low- and high-elevation plots, respectively. Initial eclosion probably occurred about a week earlier as evidenced by a few dispersing larvae landing on parked vehicles. This early eclosion probably was influenced by solar radiation at higher crown levels. Based on the temperature records from the Datapod[R] established in April, the accumulated degree-days of 255 Celsius was slightly higher but within the range mentioned by Wickman (1976a). After general eclosion, the accumulation of degree-days for larval development was similar for both elevations (fig. 1). The distribution of instars over time after eclosion is shown for our collection areas at elevations of 1707 and 2073 meters (table 1). Third instars were collected 15 to 16 days after general eclosion. At that time, 88 and 91.6 percent of the population were in the second or third instars in the two areas where we made the larval collections. The apparent early collection of fifth instars from the lower elevation plot probably was the result of egg masses hatching at an early date higher in the crown because of early warming.

We feel that the identification of third instars can be used to determine the release of areas for spray application. The proper timing would be when about 10 to 20 percent of third instars are found. For practical purposes, spray areas could be released

[1]The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. It does not constitute an official endorsement or approval by the USDA of any product or service to the exclusion of others that may be more suitable.

whenever a few third instars are collected. At that time, egg eclosion would be completed and most of the population would be second instars. This occurs at about 175 to 180 degree-days after hatch for the elevational band in our study. In both plots, the 15 days after general egg hatch agrees quite closely with previously published data (Mason 1987).

The collecting was terminated when most of the population was in the last instar, because the larvae had developed beyond the instars of major concern. Some males had started to pupate and many females were in the sixth instar. Except under stress, this is the normal pattern of development for DFTM larvae (Beckwith 1976).

Wickman (1988) shows that degree-day accumulation and insect development over five to six seasons was consistent between two sites in northeastern Oregon. Also, much of the variation between years was caused by weather before egg hatch. Therefore, although our study was conducted for only one general area in Idaho and for only 1 year, we feel that the same general proportions of instars would occur in other areas and that only the timing would differ by season and elevation.

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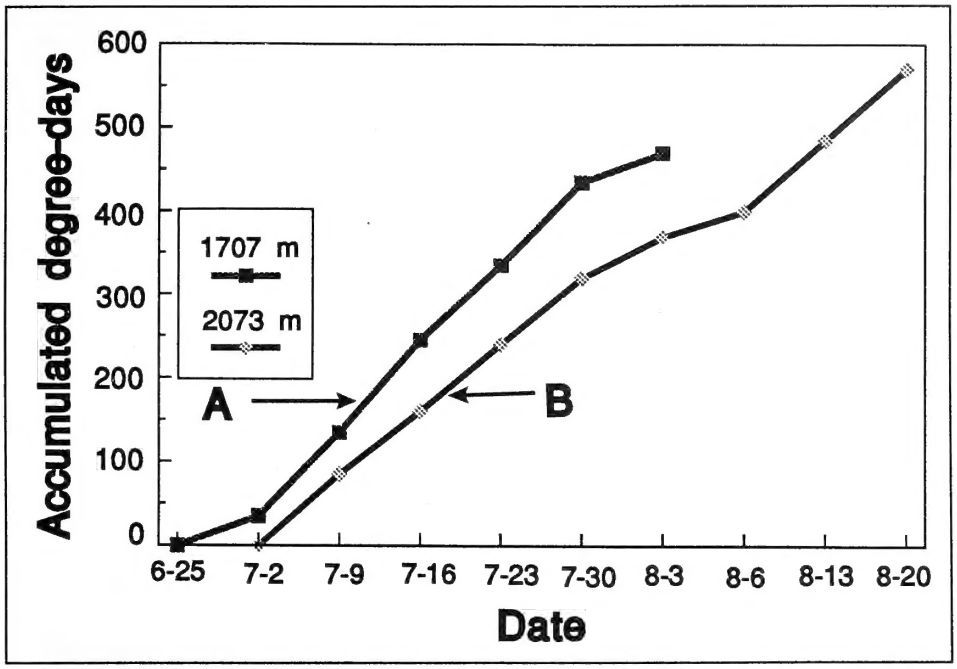

Figure 1—Approximate degree-days or time after eclosion of the Douglas-fir tussock moth before areas can be released for spraying: (A) lower elevation release point, and (B) upper elevation release point.

Table 1—Douglas-fir tussock moth instar development, Boise National Forest, Idaho, 1991

Date[a]	No. of insects	Instar[b] 1st	2d	3d	4th	5th	6th
		Low-elevation plot (1707 m)[c]					
07/04	115	100.0	—	—	—	—	—
07/08	153	28.1	71.9	—	—	—	—
07/11	167	12.0	67.0	21.0	—	—	—
07/17	105	1.0	9.5	36.2	34.3	19.0	—
07/25	144	—	—	5.6	45.1	49.3	—
08/01	133	—	—	.7	18.8	80.5	—
08/08	61	—	—	—	3.3	47.5	49.2
08/15	132	—	—	—	.8	43.9	55.3
08/22	23	—	—	—	—	13.0	87.0
		High-elevation plot (2073 m)					
07/04	5	100.0	—	—	—	—	—
07/08	237	99.6	.4	—	—	—	—
07/11	371	98.4	1.6	—	—	—	—
07/17	402	7.7	73.9	17.7	.7	—	—
07/25	487	.4	16.4	77.2	6.0	—	—
08/01	268	—	5.2	42.2	49.6	3.0	—
08/08	170	—	—	10.0	44.1	43.5	2.4
08/15	204	—	—	—	24.0	60.3	15.7
08/22	129	—	—	—	4.7	39.5	55.8

[a] General eclosion occurred on June 25 and July 2 for the low- and high-elevation plots, respectively.
[b] Percentage of total larvae.
[c] Plot elevation in meters.

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